REMARKS

In the patent US 6645828 of Sharon Farrens it is mentioned about bonding in vacuum of plates heated up to 300°C, but afterward to working in the plasma. Heating was proposed by her for the materials with the noticeable difference in the coefficients of linear temperature expansion in order to reduce stresses. Moreover, in references to her later work [2], it was shown that after plasma the supplemental heat in the vacuum before bonding not only does not improve the force of the connection between Si-SiO_2 interface, but also it leads to its noticeable decrease at temperatures >140°C. The difference of the patent US 6645828 (Sharon Farrens) with our claims is connected with the different mechanisms of hydrophilic bonding and plasma activated bonding,.

It is again repeated that classical hydrophilic bonding by the preliminary chemical hydrophilic processing of surface is carried out in moist atmosphere at room temperature. There also the variety where this bonding is carried out in the vacuum at pressures 10 - 1000 Pa at room temperature. The claims are an additional variety of hydrophilic bonding (i.e. with the hydrophilic chemical treatment), namely, in the vacuum and at moderate temperatures 80 - 350°C. Heating higher than the temperature of 350°C, for example to 450°C, also can be used, but this decreases the force of connection and very process of bonding and layer transfer becomes critical to the heating time.

The differences between the different methods of hydrophilic bonding were also presented in the work [3], which was accessible somewhat later than our national claim. The authors [3] examined the case of silicon-silicon bonding. It is clear they observed a drastic decrease in bonding strength during vacuum bonding at temperature 150°C in comparison

with RT vacuum bonding, which was explained by silanol groups' desorption from the Si surface.

The inventors found, in the case of Si-SiO_2 bonding, an increase in the bonding strength with an increase in the temperature up to 350°C, which we connect with polar nature of binding energy between silanol groups at Si-SiO_2 interface and higher final bonding temperature 350°C in our case, which was reached in the same vacuum volume instead of 200°C at the air condition, as in the work [3].

References Herein of Record 15 November 2006

1. Rieutord F, Bataillou B, Moriceau H, Dynamics of a bonding front PHYSICAL REVIEW LETTERS 94 (23): Art. No. 236101 JUN 17 2005 - in this article the absences of temperature dependence and quantitative theory of hydrophilic bonding in pointed out.

2. Authors: Dragoi, V.; Farrens, S.; Lindner, P., Plasma activated wafer bonding for MEMS, Proceedings of the SPIE, Volume 5836, pp. 179-187 (2005).

3. R. H. Esser, K. D. Hobart, and F. J. Kub, Improved Low-Temperature Si-Si Hydrophilic Wafer Bonding, Journal of The Electrochemical Society, vol. 150 no. 3, pp. G228-G231, 2003.

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